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Eight Years of Experience with Windowless Housing for Poultry

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THE first known research involving windowless structures for poultry was conducted at the West Virginia University Agricultural Experiment Station in Morgantown, West Virginia. Agricultural engineers and poultry scientists have worked together to test these structures on the University's Poultry Experimental Farm near Morgantown. The first windowless structure was erected in 1953, Figure 1. Since then, changes have been made in the insulation, ventilation system, and equipment arrangements within the building.

The purpose of this report is to present experiences and opinions supported in part by data resulting from the several years of investigation.

Why use a windowless house? American industries had been erecting new plants without windows several years before this house was erected. If humans could work in windowless structures, then why not use such structures for poultry! Maintaining a controlled atmosphere in a well-built, insulated, windowless structure is easier than in structures with windows. Undesirable fluctuations in temperatures (especially for brooding) are less likely in windowless structures because it is possible to obtain more uniform insulation in the walls. Glass, even insulating glass, allows higher heat losses than the rest of the wall.

Often windows allow heat to enter a building when it is desirable to keep it out, or they allow heat to escape when it is more economical to keep it in. Normally, windows cost more initially and cost more for maintenance than the remaining wall area. So why use windows!

Type of Construction

WALL CONSTRUCTION

Materials suitable for any other poultry house construction are satisfactory for windowless houses. At the time this house was built it seemed expedient to use cinder blocks with the cores filled with expanded mica. This is not recommended today unless the builder plans

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to add additional insulation on the inside wall surface. Cinder blocks with mica will have a U value of approximately 0.20 Btu/ (hr) (sq ft) (°F). This is not enough to assure reasonable control of the inside temperature during the winter months in the Morgantown area. Other materials and methods of construction will economically provide a U value of 0.10 and less, which now seems desirable.

ROOF CONSTRUCTION

The shed roof had a slope of ½ inch per foot of run. It was made of 2 x 6 rafters placed 24 inches on center with ¼-inch plywood roof deck and ceiling. Aluminum foil, the only insulation used, was placed ⅝ inch above the ceiling between the rafters. Doors, when open at each end of the rafters, permitted air movement between the foil and roof. Insulation characteristics for this type of construction were wholly inadequate. Moisture accumulated on the ceiling long before it appeared on the walls. After the first year this roof was removed. The spaces between the rafters were filled with expanded mica. Impregnated Celotex, 25/32 inch thick, was installed for a roof deck. It was covered with 55-pound felt roofing, half-lapped and secured with nails and asphaltic compound that was applied cold. The calculated U value was 0.06 Btu/ (hr) (sq ft) (°F). No moisture has ever collected on the ceiling of this roof. The over-all U value for the house was calculated to be approximately 0.22 Btu/ (hr) (sq ft) (°F). Actually the U value was closer to 0.34 Btu/ (hr) (sq ft) (°F). During the winter of 1960-61, at a time when there were no birds in the house, electric brooders were installed and thermostats set to hold the room temperature at 55° F. (The ventilation fans were turned off during this test.) Heat losses from the building, computed from kwhr of electricity used by the brooders, yielded an actual average U value of 0.34 Btu/ (hr) (sq ft) (°F). This was considerably higher than the calculated U value given above. This house was not considered well insulated.

Ventilation Systems

Many changes were made in the ventilation system of this 30 x 30-foot house. Initially, a 24-inch propeller fan with a capacity of approximately 7,500 cfm was mounted in the center of the ceiling to exhaust air through the roof (Figure 1). The cores of blocks placed on their side at regular intervals in the wall served as inlets for the air. Various hoods, baffles, and ducts were used in an attempt to direct the air where it would do the most good (Figures 2 and 3). Ducts were erected within 15 inches of the litter to exhaust the air at bird height (Figure 4). All

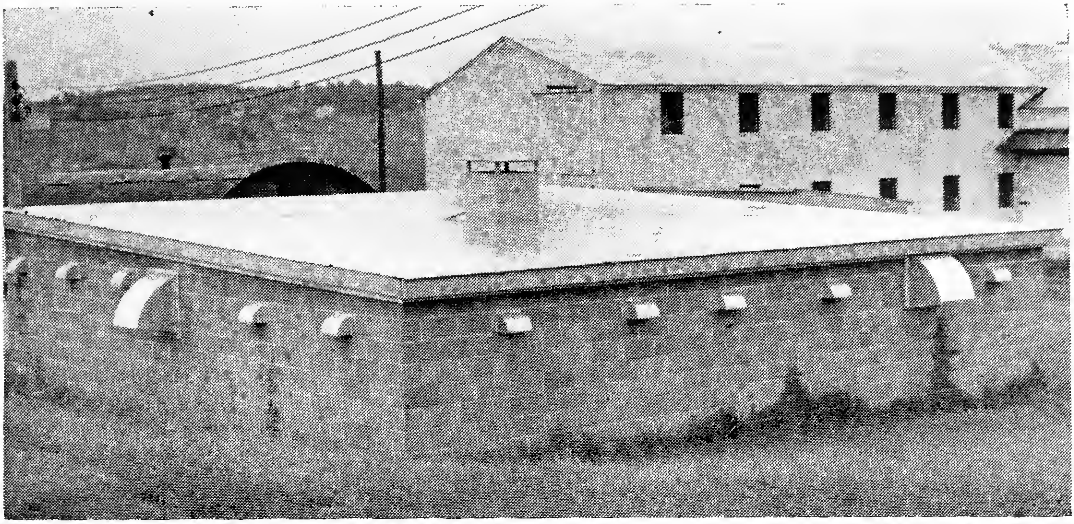

FIGURE 1. Windowless house showing original ventilation system of 24-inch exhaust fan in center of roof and small, hooded intake openings. This system was discarded in favor of a pressurized system. The large hoods in the walls cover the intake fans and exhaust openings.

of these devices and systems failed to adequately cool the birds during hot weather. There was practically no control of the moisture build-up in the litter during cold weather.

Finally, the exhaust system was discarded in favor of a pressurized system. Following the manufacturer's recommendations, two 13-inch fans were placed in the front and back walls diagonally opposite each other.

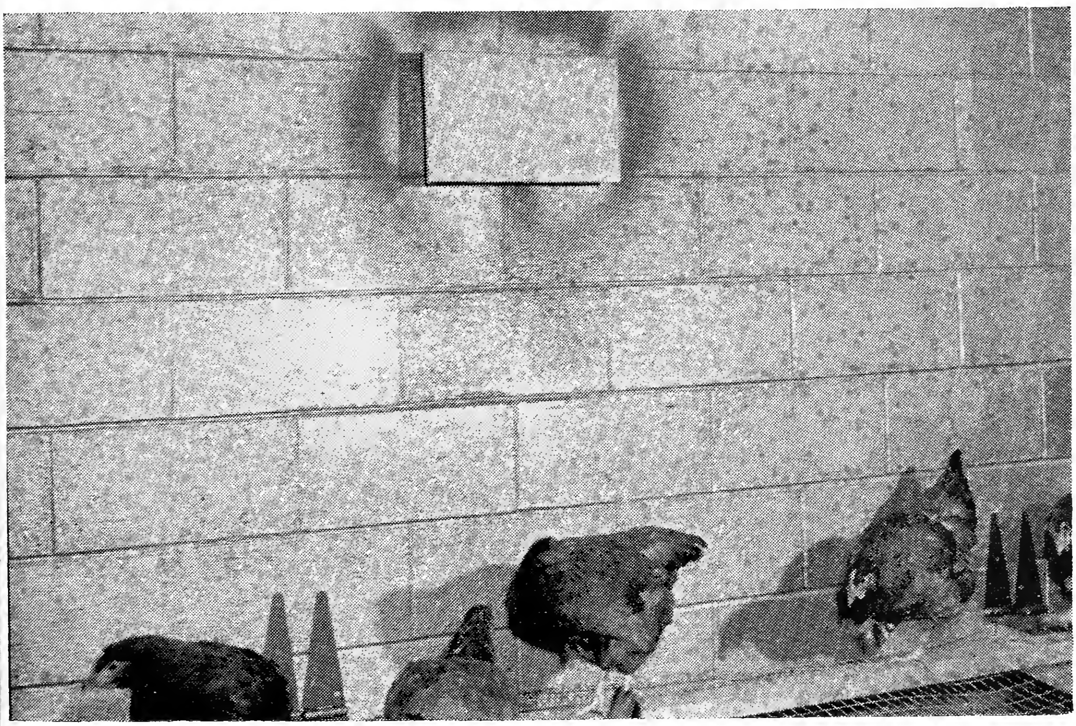

FIGURE 2. Flat plate baffle over the inlet of the wall helped to keep the wall dry, but did not direct the air over the birds and litter.

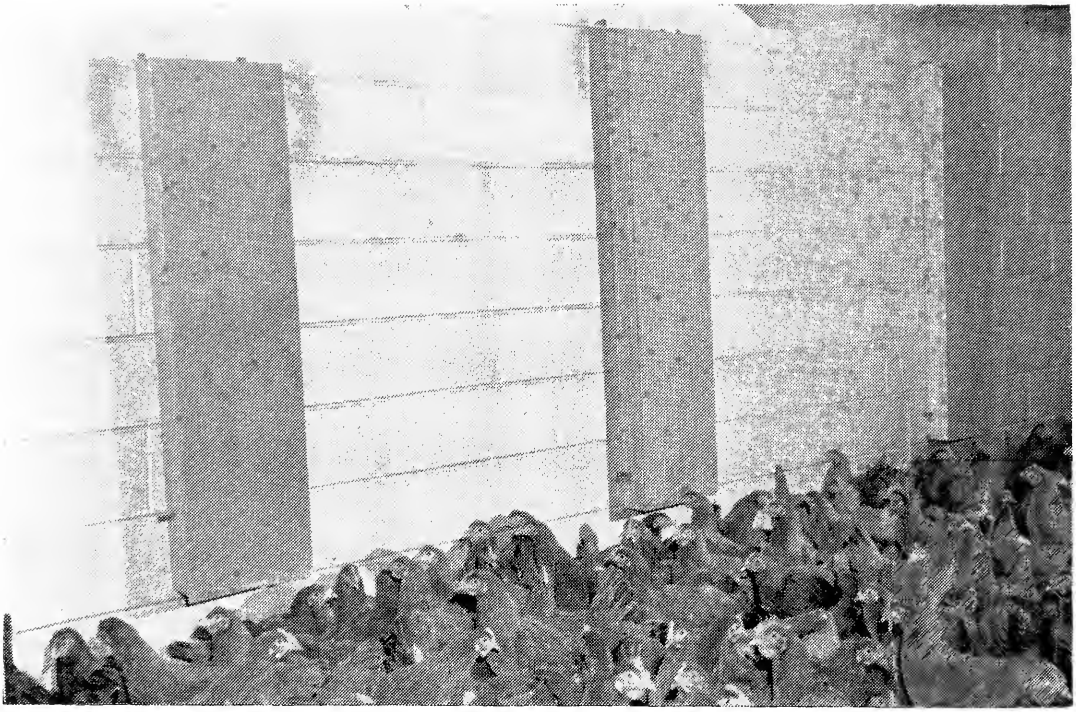

FIGURE 3. This baffle directed air to the floor, but the birds crowded around the base and they prevented good circulation.

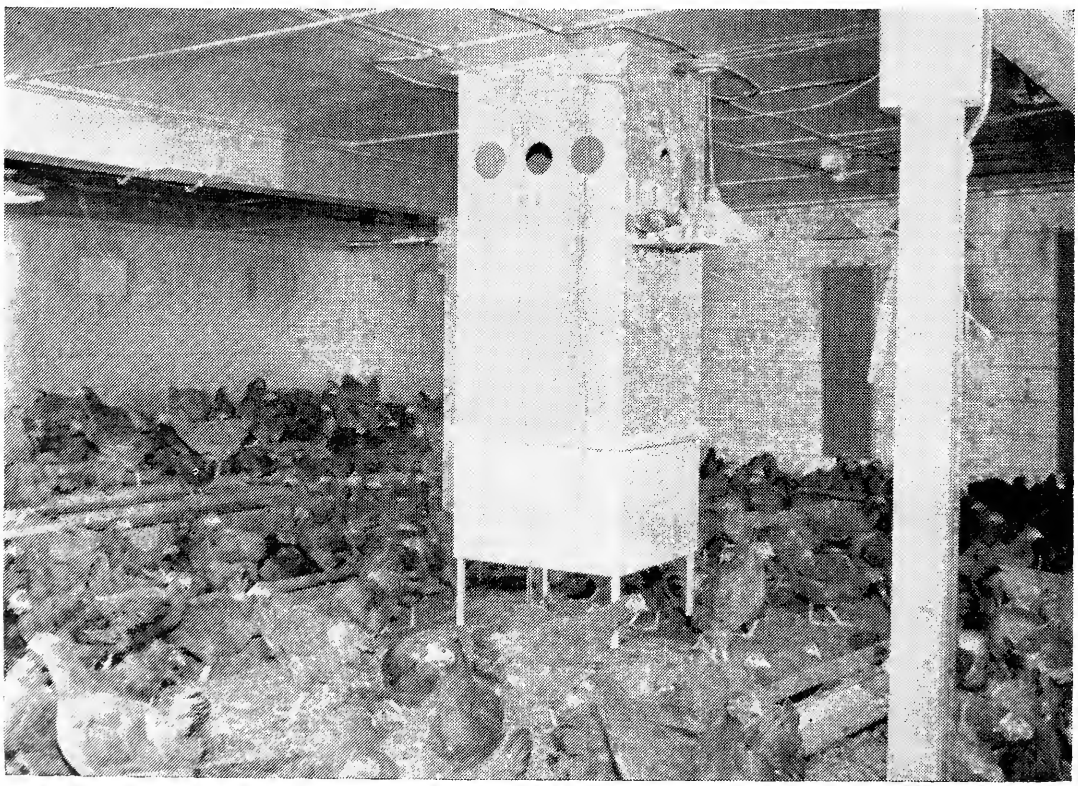

FIGURE 4. Exhaust duct in the center of the room. Small holes in the side of the duct provided some ventilation near the ceiling.

Two exhaust ports were placed in the center of the end walls about 4 feet above the floor. Immediately there was a noticeable improvement in bird comfort during hot weather. During the summer months the litter dried so much that dust became a problem. During the winter period, litter became quite damp and tended to cake in the two diagonal corners farthest from the fans. Litter remained in good condition in the areas adjacent to the fans. Both fans were moved to the center of the front and back walls the following year. Air movement from the fans to the exhaust ports was equal in either direction. This proved to be the best arrangement. It is still in use.

The manufacturers rating for the fans was 1,680 cfm at 1,725 rpm. This is not entirely correct for these fans as they were installed. Usually fans are tested in a wind tunnel free of all accessories. Placing the same fan in the wall of the poultry house, and adding the hood, screen and louvers, reduced its ability to move air. Actually when these fans were tested in a wind tunnel at the West Virginia University Agricultural Experiment Station, with all of the accessories in place, they delivered approximately 650 cfm at 0.2-inch static pressure (water gauge). This is the usual pressure encountered in the distribution duct of this particular pressurized ventilation system. The 1,300 cfm from these two fans gave better control of the poultry house environment, both summer and winter, than any arrangement tried with the single, roof-mounted fan in the exhaust system.

Arrangement of Equipment

Equipment for 300 Rhode Island Reds the first year was placed on a dirt floor with built-up litter. Single-tier roosts were placed along the back wall over a dropping pit (Figure 5). The birds received their water from automatic equipment, but feeding was done by hand. There was practically no control of the moisture build-up in the litter and the ammonia concentration became quite irritating.

A concrete floor was poured the following year, and a 4-foot wide manure pit was constructed through the center of the house. This pit was equipped with a mechanical cleaner. Three tiers of roosts were installed to accommodate 450 White Leghorns (Figure 6). The installation of the mechanical pit cleaner did more to improve the living conditions of the birds than any other single innovation. On several occasions since, it was estimated that the cleaner removed about 75 per cent of the water excreted by the birds. This was a tremendous factor in maintaining satisfactory environmental conditions in the house. Less ventilating air was required because less moisture had to be removed. Thus, heat was conserved.

FIGURE 5. Old style single-tiered roosts over dropping pit. Feeders and water fountains were on the litter.

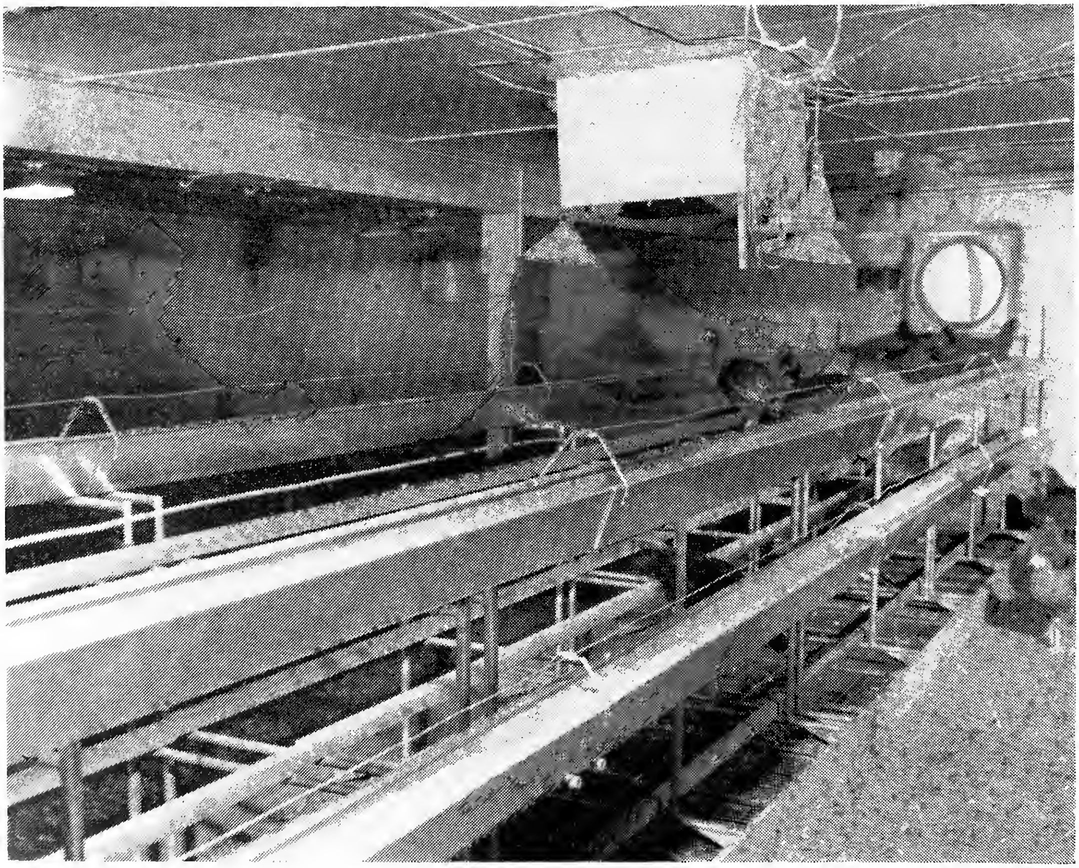

FIGURE 6. Multi-tier roosting assembly with feeding and watering equipment over a manure pit that is cleaned mechanically.

The value of the pit cleaner can best be demonstrated by making a calorimeter-psychrometric analysis of a week's data for the house. The calorimetric information was obtained from published data for poultry.* Hourly readings of temperature, humidity, and air flow obtained with potentiometers and operations recorders provided the psychrometric data (Figure 7). The data were recorded beginning at 9 a.m., for 24 hours, seven days each week. The solid curved line indicates the average amount of water removed by the ventilating air each hour of the day every day for one week.

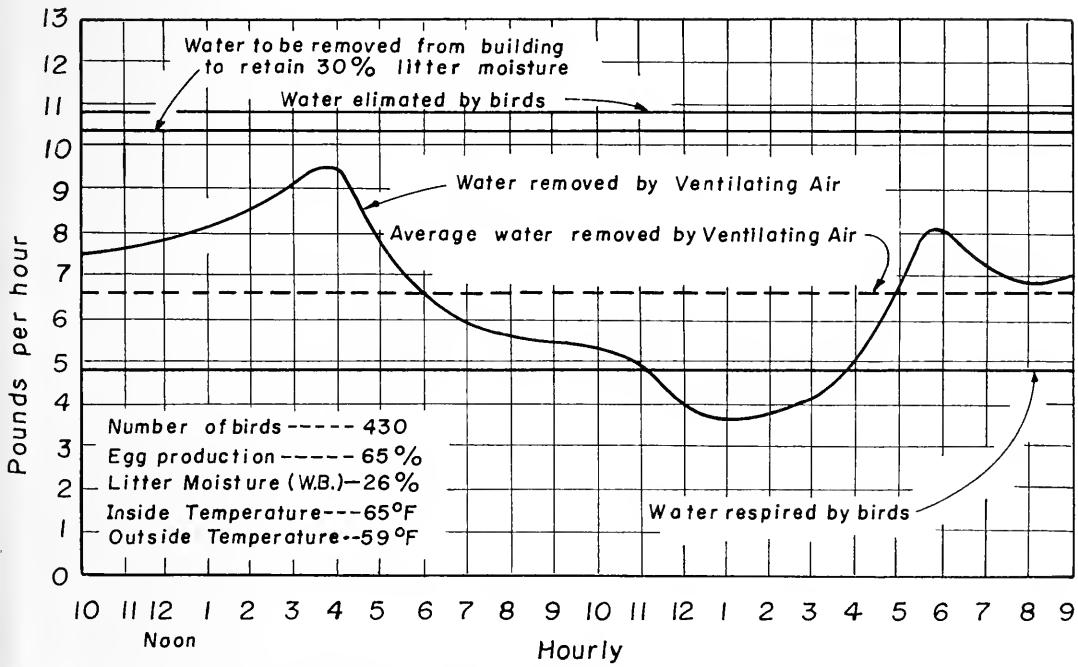

FIGURE 7. Water produced by birds and water removed by ventilation system and mechanical pit cleaner.

The ventilating air should remove the required moisture as fast as it is produced in order to maintain good environmental conditions in the poultry house. It is also important to use a mechanical pit cleaner to remove the water in the droppings before it evaporates into the room. Litter should serve as a temporary reservoir for moisture—giving it up on good drying days, absorbing it on poor drying days. During this particular week, it failed to do so between 11 p.m. and 4 a.m., but the average rate of removal was 6.6 pounds of water per hour, whereas the rate of respired moisture was 4.84 pounds per hour.

It was calculated that the birds produced 10.75 pounds of water per hour (water in eggs not included). Of this amount, 10.35 pounds had to

*Heat and Moisture Design Data for Poultry Housing. A. D. Longhouse, Hajime Ota, and Wallace Ashby. *Agricultural Engineering.* Vol. 41, No. 99, pp. 467-576, September 1960.

be removed by the combined use of the ventilation system and pit cleaner in order to hold the litter moisture content at approximately 30 per cent (wet basis). Actually, the litter moisture content dropped 2 per cent during the week. As shown in Figure 7, the water removed by the pit cleaner was 10.35 pounds minus 6.6 pounds or 3.75 pounds per hour or 88 pounds of water per day. This was the same amount of water in 75 per cent of the droppings excreted by the birds estimated to be removed by the pit cleaner. Without the pit cleaner, moisture accumulation would have occurred in the litter.

Lighting

Since electricity provides the only source of light in the windowless house, it is important to plan the lighting system well. It is essential that there be ample light over the feeders and waterers. The first lighting arrangement consisted of nine 40-watt incandescent lamps, with reflectors, six feet above the floor. This amounted to 40 watts per 100 square feet of floor area. It was inadequate lighting for the windowless house. The birds ate, drank, and roosted fairly well as long as they could literally run into feeders, waterers on the floor, and the single-tier roosts. When the equipment was changed to multiple-tier roosts with feeders and waterers, the birds practically starved to death until more light was provided so that they could see the equipment three to four feet above the floor. It required two rows of six 40-watt lamps over the roosts to provide approximately 20 foot-candles around the top roosts. The roosts were three tiers high with feeders and waterers on the top two tiers. Concentrating most of the light around the roosting and feeding area provided subdued lighting in front of the nests that were fastened to the walls. Artificial lighting for a 14-hour day required approximately 10 kwhr of electricity.

Flock Performance

Birds in the windowless house were more docile and less likely to scatter with slight provocation than birds of the same breed, strain, and age in a house with windows. Whether this was a desirable trait is open to conjecture. It could not be measured whether this factor affected egg production. It has been suggested that artificial lighting might lack some of the qualities of natural light. Also, cannibalism seemed to be less of a problem in the windowless house.

The data summarized in Table 1 indicate that mortality, approximately 9 per cent for the year, is relatively low. The average yearly egg production of 60.5 per cent, with a peak of 78.72 per cent, is good. The performance of the hens throughout this study has been good.

TABLE 1. FLOCK PERFORMANCE IN THE WINDOWLESS HOUSE, 1959-60

Month	No. Started	No. Died	Lbs. Feed	No. Doz. Eggs	Lbs. Feed/ Doz. Eggs	No. Hen Days	No. Eggs	Per Cent Mortality	Per Cent Production
Aug.	450	4	2,600	174.42	14.91	13,870	2,093	0.89	15.09
Sept.	446	3	2,561	436.00	5.87	13,338	5,232	0.67	39.23
Oct.	443	10	3.619	795.75	4.55	13,562	9,549	2.26	70.41
Nov.	433	5	3,800	845.50	4.49	12,899	10,146	1.15	78.72
Dec.	428	2	3,650	827.25	4.41	13,240	9,927	.47	74.98
Jan.	426	2	3,850	753.58	5.11	13,182	9,043	.47	68.60
Feb.	424	1	3,450	665.50	5.18	11,866	7,986	.24	67.30
Mar.	423	4	3,800	695.17	5.47	13,053	8,342	.95	64.21
Apr.	419	1	3,500	665.42	5.26	12,542	7,985	.24	63.97
May	418	1	3,500	687.17	5.09	12,950	8,246	.24	63.98
June	417	1	3,350	645.00	5.19	13,490	7,740	.24	62.26
July	416	1	3,200	643.08	4.98	12,877	7,717	.24	60.22
Aug.	415	7	2,800	612.25	4.57	12,728	7.347	1.69	58.00
Year	450	**42**	**43,680**	**8,446.09**	**5.17**	**169,597**	101,353	**9.33**	**60.54**